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Spirit Lake
Dickinson County, Iowa

Corvallis Environmental Research Lab, Oreg

Prepared for

Environmental Monitoring and Support Lab, Las Vegas, Nev

Aug 76

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

PRICES SUBJECT TO CHANGE

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NATIONAL EUTROPHICATION SURVEY

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REPORT

ON

SPIRIT LAKE

DICKINSON COUNTY

IOWA

EPA REGION VII

WORKING PAPER No. 506

WITH THE COOPERATION OF THE

IOWA DEPARTMENT OF ENVIRONMENTAL QUALITY

AND THE

IOWA NATIONAL GUARD

AUGUST, 1976

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Iowa Department of Environmental Quality for professional involvement, to the Iowa National Guard for conducting the tributary sampling phase of the Survey, and to those wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the Water Quality Division of the Department of Environmental Quality provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

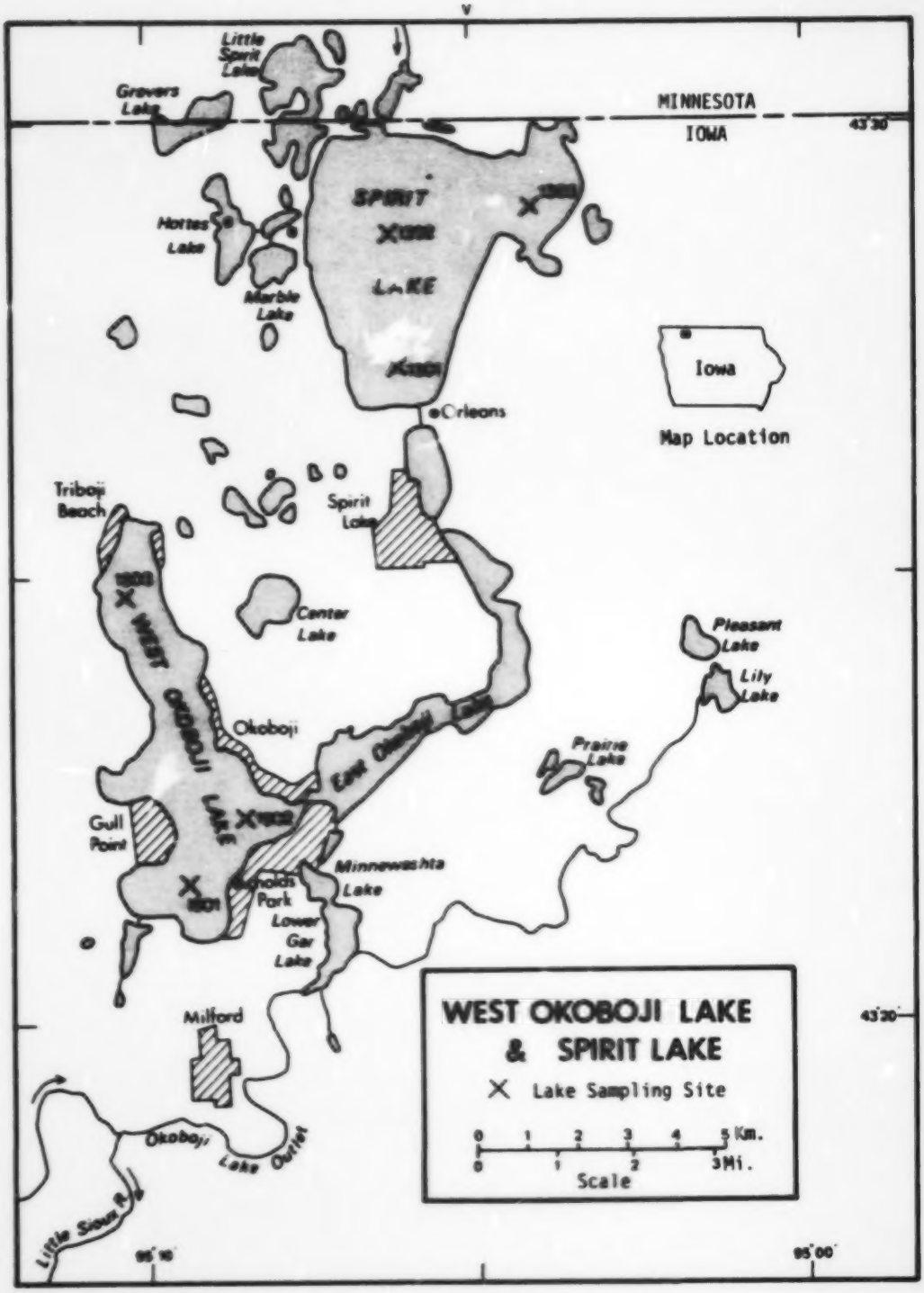
Major General Joseph G. May, the Adjutant General of Iowa, and Project Officer Colonel Cleadeth P. Woods, who directed the volunteer efforts of the Iowa National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF IOWA

LAKE NAME	COUNTY
Anquabi	Warren
Big Creek Reservoir	Polk
Black Hawk	Sac
Clear	Cerro Gordo
Darling	Washington
Lost Island	Clay, Palo Alto
MacBride	Johnson
Prairie Rose	Shelby
Rathbun Reservoir	Appanoose, Wayne
Red Rock Reservoir	Marion
Rock Creek	Jasper
Silver	Worth
Spirit	Dickinson
Viking	Montgomery
West Okoboji	Dickinson


Little Spirit Lake
Grovers Lake
MINNESOTA
IOWA
43°30'
SPIRIT LAKE
Hortes Lake
Marble Lake
Orleans
Iowa
Map Location
Triboji Beach
Spirit Lake
WEST OKOBOJI LAKE
Center Lake
Pleasant Lake
Lily Lake
Okoboji
East Okoboji Lake
Prairie Lake
Gull Point
Minnewashta Lake
Arnolds Park
Lower Gar Lake
Milford
WEST OKOBOJI LAKE
& SPIRIT LAKE
Lake Sampling Site
0 1 2 3 4 5 Km.
0 1 2 3 Mi.
Scale
43°20'
Okoboji Lake Outlet
Little Sioux R.
95°10'
95°00'

SPIRIT LAKE

STORET NO. 1913

I. INTRODUCTION*:

Spirit Lake was included in the National Eutrophication Survey as a water body of interest to the Iowa Department of Environmental Quality. Tributaries and nutrient sources were not sampled, and this report relates only to the lake sampling data.

Spirit Lake is one of a chain of natural lakes collectively known as the Iowa Great Lakes. Glacial in origin, the lake is quite shallow but has the largest surface area of any of the natural lakes in the state. Besides being used as a public water supply, it is a valuable recreational asset. Activities such as camping, fishing, and swimming attract many Iowa residents and out-of-state visitors; and private residences, cabins, and commercial establishments ring the shoreline. Abundant gamefish present include perch, smallmouth and largemouth bass, and walleyes. Some bluegills, crappies, and channel catfish can also be caught. The watershed is almost entirely agricultural.

All of the Iowa Great Lakes have been classified as eutrophic but in varying degrees. Nuisance algal blooms are most severe in Lower Gar Lake and Lake East Okoboji, although all of the lakes have summer algae problems. There has been an apparent decrease of macrophyte and muolluscan species diversity in recent years, as well as an increase in the abundance

* Description of the lake from Bachmann and Jones (1974).

of blue-green algae. However, sediment core samples indicate that the Iowa Great Lakes chain has been eutrophic for several thousand years.

It has been estimated that the lake chain as a whole receives only 3% of the total phosphorus load from urban sources with the remainder contributed by agricultural runoff and other non-point sources; feedlots contribute about 10% of the phosphorus load to Spirit Lake.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Spirit Lake is eutrophic. It ranked first in overall trophic quality when the 15 Iowa lakes and reservoirs sampled in 1974 were compared using a combination of six water quality parameters*. However, based on their more extensive studies, Bachman and Jones (op. cit.) consider West Okoboji Lake to be of better overall trophic quality than Spirit Lake.

None of the other Iowa water bodies had less median total phosphorus and median orthophosphorus, three had less median inorganic nitrogen and mean chlorophyll a, and two had greater mean Secchi disc transparency.

Survey limnologists observed some surface phytoplankton during the July sampling at all stations.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Spirit Lake was phos-

* See Appendix A.

phorus limited at the time the sample was collected (04/23/74). The lake data indicate phosphorus limitation at stations 1 and 2 in April but nitrogen limitation at station 3. Nitrogen limitation is indicated at all three stations in September.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 23.00 kilometers^2.
2. Mean depth: 5.5 meters.
3. Maximum depth: 7.3 meters.
4. Volume: 126.500 x 10^6 m^3.
5. Mean hydraulic retention time: Unknown.

C. Precipitation*:

1. Year of sampling: 71.8 centimeters.
2. Mean annual: 70.5 centimeters.

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† Table of metric conversions--Appendix B.
†† Harrison, 1975.
* See Working Paper No. 175, "...Survey Methods, 1973-1976".

IV. LAKE WATER QUALITY SUMMARY

Spirit Lake was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at three stations on the lake (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 4.6 meters at station 1, 4.9 meters at station 2, and 4.6 meters at station 3.

The sampling results are presented in full in Appendix C and are summarized in the following table (the July nutrient samples were not preserved properly and were not analyzed).

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SPIRIT LAKE
STORET CODE 1913

PARAMETER	1ST SAMPLING (4/23/74) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/ 9/74) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/23/74) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	8.5 - 8.7	8.6	8.7	24.1 - 24.9	24.6	24.6	15.2 - 15.5	15.3	15.3
DISS OXY (MG/L)	10.0 - 10.6	10.3	10.3	6.0 - 8.2	7.0	8.0	9.0 - 9.4	9.2	9.2
CNDCTVY (MCROMO)	332. - 337.	335.	335.	544. - 555.	549.	548.	367. - 369.	368.	368.
PH (STAND UNITS)	8.4 - 8.4	8.4	8.4	8.6 - 8.7	8.6	8.6	8.3 - 8.4	8.4	8.4
TOT ALK (MG/L)	186. - 193.	191.	192.	****** -**********			167. - 182.	174.	173.
TOT P (MG/L)	0.030 - 0.049	0.037	0.034	****** -**********			0.038 - 0.050	0.045	0.043
ORTHO P (MG/L)	0.002 - 0.019	0.007	0.004	****** -**********			0.006 - 0.013	0.009	0.009
NO2+NO3 (MG/L)	0.080 - 0.110	0.097	0.100	****** -**********			0.020 - 0.030	0.021	0.020
AMMONIA (MG/L)	0.030 - 0.050	0.041	0.040	****** -**********			0.020 - 0.040	0.030	0.030
KJEL N (MG/L)	0.900 - 1.100	0.967	1.000	****** -**********			1.200 - 1.400	1.270	1.300
INORG N (MG/L)	0.120 - 0.160	0.138	0.140	****** -**********			0.040 - 0.060	0.051	0.050
TOTAL N (MG/L)	0.990 - 1.210	1.063	1.080	****** -**********			1.220 - 1.420	1.299	1.320
CHLRPYL A (UG/L)	2.3 - 2.6	2.5	2.5	13.8 - 15.4	14.6	14.7	19.5 - 22.4	20.8	20.4
SECCHI (METERS)	2.7 - 3.7	3.1	3.0	1.5 - 1.5	1.5	1.5	1.1 - 1.4	1.2	1.2

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/23/74	1. Flagellates	912
	2. Dinobryon sp.	240
	3. Cryptomonas sp.	144
	4. Aphanothece sp.	96
	5. Dinoflagellates	48
	Other genera	97
	Total	1,537
07/09/74	1. Aphanocapsa sp.	1,569
	2. Aphanizomenon sp.	262
	3. Schroederia sp.	262
	4. Anabaena sp.	232
	5. Cryptomonas sp.	145
	Other genera	174
	Total	2,644
09/23/74	1. Aphanothece sp.	1,182
	2. Anabaena sp.	734
	3. Aphanizomenon sp.	326
	4. Coelosphaerium sp.	285
	5. Oscillatoria sp.	245
	Other genera	937
	Total	3,709

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/23/74	1	2.6
	2	2.3
	3	2.5
07/09/74	1	15.4
	2	14.7
	3	13.8
09/23/74	1	22.4
	2	20.4
	3	19.5

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	0.109	0.1
0.050 P	0.055	0.109	3.1
0.050 P + 1.0 N	0.055	1.109	16.1
1.0 N	0.005	1.109	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Spirit Lake was low at the time the assay sample was taken (04/23/74). The results also indicate phosphorus limitation at that time. Note the significant increase in yield when only orthophosphorus was added and the lack of yield response when only nitrogen was added.

The lake data indicate phosphorus limitation in April at stations 1 and 2; i.e., the mean inorganic nitrogen to orthophosphorus ratios were 45 to 1 and 33 to 1, respectively. However, nitrogen limitation is indicated at station 3 (the mean N/P ratio was 11/1).

The September lake data indicate nitrogen limitation at all stations; i.e., the mean N/P ratios were 6/1 or less, and nitrogen limitation would be expected

V. LITERATURE REVIEWED

Anonymous, 1974. Management plan for water quality--Iowa Great Lakes. E. A. Hickok and Assoc., Wayzata, Minnesota.

Bachmann, Roger W., and John R. Jones, 1974. Water quality in the Iowa Great Lakes. MS, Dept. of Zoo. & Ent., IA St. U., Ames.

Harrison, Harry M., 1975. Personal communication (lake morphometry). IA Cons. Comm., Des Moines.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN SD	MEDIAN DISS ORTHO P
1901	LAKE ACQUABI	0.062	0.335	469.333	8.600	8.200	0.009
1902	BIG CREEK RESERVOIR	0.046	6.465	438.500	16.867	14.800	0.011
1903	BLACK HAWK LAKE	0.185	0.130	488.167	49.740	15.000	0.020
1904	CLEAR LAKE	0.059	0.070	465.125	17.400	8.600	0.010
1905	LAKE DARLING	0.077	1.475	482.500	13.817	9.200	0.012
1906	LOST ISLAND LAKE	0.146	0.065	421.167	36.100	8.400	0.021
1907	LAKE MACBRIDE	0.061	2.035	458.444	17.867	15.000	0.010
1908	PRAIRIE ROSE LAKE	0.056	0.210	463.667	17.350	8.600	0.010
1909	RATHBUN RESERVOIR	0.071	1.170	475.889	12.039	14.000	0.008
1910	RED ROCK LAKE	0.180	1.880	473.400	14.730	14.000	0.104
1911	ROCK CREEK LAKE	0.065	1.400	480.500	18.367	8.400	0.007
1912	SILVER LAKE	0.193	0.565	482.667	95.300	10.000	0.034
1913	SPIRIT LAKE	0.041	0.090	422.667	12.622	9.000	0.007
1914	VIKING LAKE	0.075	0.130	459.000	26.033	14.200	0.017
1915	WEST LAKE OKOBOJI	0.046	0.060	380.444	7.722	15.000	0.017

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NU
1901	LAKE ACQUABI	57 (8)	50 (7)	43 (6)	93 (13)	100 (14)	79 (11)	422
1902	BIG CREEK RESERVOIR	89 (12)	0 (0)	79 (11)	57 (8)	21 (3)	50 (7)	296
1903	BLACK HAWK LAKE	7 (1)	68 (9)	0 (0)	7 (1)	7 (0)	21 (3)	110
1904	CLEAR LAKE	71 (10)	86 (12)	50 (7)	36 (5)	75 (10)	64 (8)	382
1905	LAKE DARLING	29 (4)	21 (3)	14 (2)	71 (10)	57 (8)	43 (6)	235
1906	LOST ISLAND LAKE	21 (3)	93 (13)	93 (13)	14 (2)	89 (12)	14 (2)	324
1907	LAKE MACBRIDE	64 (9)	7 (1)	71 (10)	50 (7)	7 (0)	64 (8)	263
1908	PRAIRIE ROSE LAKE	79 (11)	57 (8)	57 (8)	43 (6)	75 (10)	64 (8)	375
1909	RATHBUN RESERVOIR	43 (6)	36 (5)	29 (4)	86 (12)	39 (5)	86 (12)	319
1910	RED ROCK LAKE	14 (2)	14 (2)	36 (5)	64 (9)	39 (5)	0 (0)	167
1911	ROCK CREEK LAKE	50 (7)	29 (4)	21 (3)	29 (4)	89 (12)	96 (13)	314
1912	SILVER LAKE	0 (0)	43 (6)	7 (1)	0 (0)	50 (7)	7 (1)	107
1913	SPIRIT LAKE	100 (14)	79 (11)	86 (12)	79 (11)	64 (9)	96 (13)	504
1914	VIKING LAKE	36 (5)	68 (9)	64 (9)	21 (3)	29 (4)	32 (4)	250
1915	WEST LAKE OKOBOJI	89 (12)	100 (14)	100 (14)	100 (14)	7 (0)	32 (4)	428

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	1913	SPIRIT LAKE	504
2	1915	WEST LAKE OKOBOJI	428
3	1901	LAKE ACQUABI	422
4	1904	CLEAR LAKE	382
5	1908	PRAIRIE ROSE LAKE	375
6	1906	LOST ISLAND LAKE	324
7	1909	RATHBUN RESERVOIR	319
8	1911	ROCK CREEK LAKE	314
9	1902	BIG CREEK RESERVOIR	296
10	1907	LAKE MACBRIDE	263
11	1914	VIKING LAKE	250
12	1905	LAKE DARLING	235
13	1910	RED ROCK LAKE	167
14	1903	BLACK HAWK LAKE	110
15	1912	SILVER LAKE	107

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/10/21

191301
43 27 21.0 095 06 08.0
SPIRIT LAKE
19 IOWA

11EPALES
3

2111202
0019 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/23	10 00	0000	8.7		108	336	8.40	186	0.040	0.900	0.100	0.002
	10 00	0005	8.7	10.4		334	8.40	190	0.040	0.900	0.110	0.006
	10 00	0015	8.7	10.4		337	8.40	192	0.040	1.000	0.090	0.004
74/07/09	14 25	0000	24.7	6.0	60	555	8.60					
	14 25	0005	24.6	8.0		552	8.60					
	14 25	0015	24.1	7.6		553	8.60					
74/09/23	14 55	0000	15.3	9.0	54	368	8.32	173	0.030	1.300	0.020K	0.006
	14 55	0005	15.3	9.4		368	8.34	176	0.030	1.300	0.020	0.008
	14 55	0014	15.3	9.2		368	8.39	173	0.030	1.400	0.020	0.012

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/23	10 00	0000	0.031	2.6	
	10 00	0005	0.043		
	10 00	0015	0.049		
74/07/09	14 25	0000		15.4	
74/09/23	14 55	0000	0.038	22.4	
	14 55	0005	0.041		
	14 55	0009			1.0
	14 55	0014	0.043		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/21

191302
43 29 03.0 095 06 18.0
SPIRIT LAKE
19 IOWA

11EPALES 2111202
3 0020 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/23	10 20	0000	8.7		144	335	8.40	190	0.050	0.900	0.100	0.004
	10 20	0005	8.7	10.0		335	8.40	192	0.040	0.900	0.090	0.004
	10 20	0016	8.7	10.0		336	8.40	192	0.040	1.000	0.080	0.004
74/07/09	14 49	0000	24.6	8.2	60	550	8.60					
	14 49	0005	24.5	7.2		548	8.60					
	14 49	0016	24.3	7.2		547	8.60					
74/09/23	14 00	0000	15.2	9.2	42	367	8.39	182	0.030	1.300	0.020K	0.013
	14 00	0005	15.2	9.2		367	8.40	167	0.030	1.200	0.030	0.009
	14 00	0015	15.2	9.2		368	8.40	172	0.030	1.200	0.020K	0.012

81

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	322.7 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/23	10 20	0000	0.030	2.3	
	10 20	0005	0.038		
	10 20	0016	0.030		
74/07/09	14 49	0000		14.7	
74/09/23	14 00	0000	0.038	20.4	
	14 00	0005	0.045		
	14 00	0009			1.0
	14 00	0015	0.048		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/21

191303
43 29 20.0 095 03 58.0
SPIRIT LAKE
19 IOWA

11EPALES
3

2111202
0018 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/23	10	35 0000	8.5		120	334	8.40	193	0.050	1.100	0.110	0.019
	10	35 0005	8.6	10.2		334	8.40	193	0.040	1.000	0.100	0.013
	10	35 0014	8.5	10.6		332	8.40	193	0.030	1.000	0.090	0.006
74/07/09	15	13 0000	24.9	8.0	60	544	8.70					
	15	13 0005	24.8	8.0		544	8.70					
	15	13 0014	24.6	8.0		544	8.70					
74/09/23	14	30 0000	15.5	9.4	48	368	8.40	173	0.030	1.300	0.020K	0.007
	14	30 0005	15.4	9.2		368	8.37	173	0.040	1.300	0.020K	0.009
	14	30 0015	15.4	9.4		369	8.39	173	0.020	1.200	0.020K	0.008

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/23	10	35 0000	0.033	2.5	
	10	35 0005	0.042		
	10	35 0014	0.034		
74/07/09	15	13 0000		13.8	
74/09/23	14	30 0000	0.040	19.5	
	14	30 0005	0.042		
	14	30 0009			1.0
	14	30 0015	0.046		

K VALUE KNOWN TO BE
LESS THAN INDICATED

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